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AN EXPERIMENTAL STUDY OF VISUAL FORM¹

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INTRODUCTION

The present study has its origin in Schumann's experimental investigation of the visual *Gestaltqualität*² or *Form of Combination*.³ We had three reasons for resuming Schumann's work. In the first place, his analyses seemed to be of so great importance from the methodological point of view as to justify the spending of time upon their repetition. Secondly, Schumann's work was done before the publications of the Würzburg school had brought out the issue of process and meaning; and we might therefore hope to carry his analyses further, and to give them a systematic setting. Thirdly, the recent criticism by Bühler of Titchener's position, which (*e.g.*, in his Textbook) agrees substantially with that of Schumann, shows misunderstandings which can best be removed by the exhibition and discussion of experimental results.

Our experimental work has thus been partly a repetition, and more largely an extension, of certain of Schumann's experiments. It consisted of five series of observations, which

¹ From the Psychological Laboratory of Cornell University.

² See F. Schumann, *Beiträge zur Analyse der Gesichtswahrnehmungen*, I, *Zeit. f. Psychol.*, 23, 1900, 1ff.; II, *ibid.*, 24, 1900, 1ff.; IIIa, *ibid.*, 30, 1902, 241ff.; IIIb, *ibid.*, 30, 1902, 321ff.; IV, *ibid.*, 36, 1904, 161ff. References to these articles will be indicated by I, II, etc.

³ The English term 'Form of Combination' seems to have been introduced by G. F. Stout, *Analytic Psychology*, I, 1896, 65ff. It is not our purpose here to enter upon the history of the concept, or to discuss in detail the various theories which have been propounded since C. von Ehrenfels published his well-known article "Ueber Gestaltqualitäten," *Vjs. f. wiss. Philos.*, 14, 1890, 249ff.; the reader may be referred to A. Gelb, *Theoretisches über "Gestaltqualitäten," Zeit. f. Psychol.*, 58, 1910-11, 1ff., and to K. Bühler, *Die Gestaltwahrnehmungen*, I, 1913.

were briefly as follows. I. We presented to our observers white cards covered with a pattern of equally spaced black figures, squares, circles, lines, etc. Under observation these figures fell into natural groups. *O*'s task was to report the experience accompanying group-formation. II. We presented cards upon which figures, such as circle, barrel, dumbbell, were partially outlined in black upon the white background. Under observation these white figures tended to complete themselves. *O* was required to describe the figures which resulted from the realization of this tendency. III. A figure, *e.g.*, a square outlined in black on a large white field, was gradually changed during presentation to a new figure, *e.g.*, an oblong. *O* was required to describe the forms observed. IV. A figure, *e.g.*, a square drawn in black upon a white ground, was instantaneously replaced by another figure, *e.g.*, a triangle. *O*'s task was the same as in the preceding experiment. V. Figures were indicated by white dots set on a large black field (thus, 3 dots represented a triangle, 4 a square, etc.); these figures could be drawn out or compressed into new figures while observation was in course. *O*'s task was again the same as in III. We take up the experiments in the order given, and describe both the conditions under which the observations were made and the results obtained from them.

SECTION I

In this experiment we used patterned cards, of the kind which Schumann had found favorable to group-formation. Our object was to discover whether a longer and more systematic course of observation would push the analysis of the group-experiences further than Schumann had been able to carry it.

Our stimuli were ten white cards, about 25 cm. square, on which patterns of equidistantly spaced figures, such as lines, squares, diamonds, were drawn in black. The patterns were of four types.⁴ Two cards were filled respectively by parallel vertical and horizontal lines, drawn at distances of 1.5 cm. Four cards showed 64 discrete figures, such as squares or diamonds, equidistantly spaced in both directions at 1.5 cm. The maximal dimension of these figures was also 1.5 cm. In the other two types of stimulus-card the figures were not discrete but contiguous. Two cards were marked off into white squares of 1.5 cm. side, formed in the one by vertical and horizontal cross-lines and in the other by diagonals. The

⁴Diagrams illustrating these four types of pattern are given by Schumann in Figs. 1, 2, 5 and 6. See I, 7ff.

remaining two cards were of checkerboard pattern and contained alternate white and black units, in the form respectively of diamonds and triangles.

The cards were presented in an exposure apparatus, before which *O* sat at a distance of some 2m. On the average, the series of 10 was presented to each one of the five *O*'s 26 times. The total number of presentations to all *O*'s was 1,281. With the exception of a single series in which the time of exposure was varied, the duration of presentation was 5 sec.

The observers were Dr. C. L. Friedline (F), graduate student in psychology; Dr. J. M. Gleason (G), instructor in psychology; Dr. L. B. Hoisington (H), instructor in psychology; Mr. B. L. Swartz (S), assistant in psychology; and Mrs. M. J. Zigler. The two last-named were untrained; the others had had varied training in observation.

At first the *O*'s worked under the following instruction: "I shall show you a series of cards on which a number of figures are drawn. You are to observe the figures carefully and, when the screen drops, to describe what you have seen." Later, with a view to fuller description of the group-formations, the instruction was changed to read: "I shall show you a card on which a number of discrete figures are drawn. From the elements form a natural group. When the curtain falls, describe as accurately as you can what you observe when the group has formed." After some hundreds of observations had been made, the reports of F, G and Z were examined, with the idea that characteristic or "natural" groupings might come to light. We found, however, that certain cards lent themselves more naturally to one, and other cards to another kind of grouping. Acting upon this suggestion, we now required the three *O*'s to form groups of a certain number of elements, or of a certain shape, according to their known tendency in presence of the particular stimuli; we hoped in this way to facilitate grouping, and also to secure still more complete descriptions. We further provided a push-button, connected electrically with a stop-watch, and asked the *O*'s to signal the appearance of a group.

H and S continued under the instruction to form natural groups, S until the end, and H until near the end of the experiment. In the last few sittings with H the time of exposure was varied at haphazard in 1, 2, 3, 4 and 5 sec. exposures.

Results.—All *O*'s reported groupings from the first. During the earlier work the reports generally gave successive groupings as the eyes moved about over the card; later we attempted to control conditions so that *O* should obtain only

one group-experience during a presentation. The general number of elements constituting the groups, the variability from the general rule, and individual differences were irrelevant to our purpose. Our primary concern lay in the description of group-formations; in whatever it is that differentiates the elements grouped from the similarly drawn ungrouped elements. The whole course of our experimental procedure was aimed to secure this description. The push-button was introduced to allow *O* to signal the appearance of a group, and to halt the exposure for a report on the first group observed.

The results may be reported in two classes: *A*, those characterising groups in which the elements are of the discrete pattern; and *B*, those pertaining to groups in which the elements are contiguous.

A.—The descriptions given by all *O*'s indicate that the marks differentiating a group may belong (1) to the intervening spaces separating the discrete elements, (2) to the elements grouped, and (3) to tied imagery, which sometimes plays a part in group-formation. (1) The white spaces surrounding a group may become (*a*) broader and (*b*) qualitatively lighter or darker than the intra-group spaces.⁵ These distinguishing marks were noted by all *O*'s at first, and persisted as the predominant facts for the untrained *O*'s to the end. The more trained observers, however, soon described changes (2) in the elements themselves, and as the work progressed these were reported as the more salient facts.⁶ The elements of the group were described by all *O*'s as (*a*) blacker in quality, (*b*) clearer, (*c*) more extended, and (*d*) standing out in perspective. Two *O*'s, G and H, also reported that the elements grouped possessed (*e*) a greater intensity. Four of the five *O*'s also indicate the influence (3) of tied imagery in separating the groups. There were sporadic reports of "thread-like black lines," "gray lines," "gray streaks," "faint gray lines," "shadowy gray lines," which connected the elements of a group or formed its boundary.⁷

B.—Group-formations in the contiguous patterns were characterized (1) by alterations in the black lines bounding the groups, and (2) by changes in the elements themselves. (2) The black contour lines were described as (*a*) qualitatively blacker, (*b*) clearer, (*c*) more extended or broader, and (*d*) more sharply defined at the edges, than

⁵ Schumann reports that the white intervening spaces *hervortreten* or *auffallen im Bewusstsein*, obtrude in consciousness, while the intra-spaces recede, *zurücktreten*; and that when these spaces obtrude they are broader. The obtrusion, he says, is not necessarily a matter of perspective, although he indicates that perspective plays a minor part. See I, 9ff.

⁶ In another place Schumann emphasizes change in extent as the fundamental factor in the experience of group-formation. This applies essentially to the spaces separating the groups from the other elements; it may, however, apply also to the elements of the group themselves. In the latter case the facts are very undependable, afford "ein sehr unsicheres Kriterium." II, 32.

⁷ Schumann did not report the influence of tied imagery in these groupings.

the other black lines on the card. G and H again reported (*e*) that the lines were enhanced in intensity. The attributive changes in the elements themselves (2) were noted more generally in the checker-board patterns, although with the trained *O*'s in particular they were also found with the small white square-patterns. The grouped elements were characterized by (*a*) changes in quality, (*b*) greater clearness, (*c*) greater extent, and (*d*) perspective of the group. G and H also reported (*e*) an increase of intensity of the grouped elements.

Unless specially referred, the facts given above were reported by all *O*'s. The untrained *O*'s tended to find differences in the separating spaces or lines, while the more trained *O*'s soon tended with practice to rely more and more upon the alterations in the elements.⁸ We thus arrived at a greater variety of attributive changes in the group-experiences than Schumann attained; and thereby we have rendered still more plausible his contention that form can be adequately accounted for in the phenomena of experience themselves.

The reports gave the further suggestion of stages in the temporal course of the grouping-experiences, stages which indicated a probable correlation of process and meaning. All *O*'s either implied or definitely distinguished three such stages in temporal course. First comes a period of *expectancy*, in which *O* is expectantly set for a group to emerge from the isolated elements. Secondly, a group appears, and is attended by certain attributive changes with which an *abstract* or geometrical meaning of form is correlated. Thirdly, the group takes on the meaning of an *object*, and at the same time the attributive changes become more pronounced. The effects of perspective and tied imagery were essentially confined to the groups which assumed objective reference. These hints of correlation induced us to pursue the experiments farther with more promising materials.

SECTION II

Again the suggestion of appropriate materials comes from Schumann.⁹ We used white stimulus-cards on which plane white figures were partially outlined by black characters placed at various intervals along their contours. Our problem here was twofold: first, we desired to get a full description of the perceptual experiences when the figures were imaginably completed; and secondly, we anticipated that experiences wherein the perception of form is more or less gradual in its

⁸ Schumann here emphasizes the obtrusion of the limiting lines in consciousness. These limiting lines are reported by him as "schwärzer und schärfer begrenzt." I, 11ff.

⁹ Schumann's Figure 7 gives the principle upon which the construction of these cards is based. See I, 13.

development would throw into clearer relief the relationship of process and meaning.

We used a set of 18 stimulus-cards, about 23 by 27.5 cm. A heavy black border framed the cards in the shape of a rectangle, triangle, parallelogram. The 18 figures partially outlined within these frames were: 1 square (Schumann's figure), 2 disc, 3 barrel, 4 oval, 5 hourglass, 6 basket, 7 figure 8, 8 dumbbell, 9 crescent moon, 10 scroll, 11 double axe, 12 horse shoe, 13 four circles, 14 crescent and disc, 15 pointed ellipse, 16 heart, 17 three cherries, and 18 spinning top. Every figure extended over the entire vertical distance within the black frame, and its outline was partially indicated at the sides by black characters of variable shape.

The cards were shown at haphazard in an exposure-apparatus on an average of 9 times for all cards and all *O*'s; the total number of presentations to ten *O*'s was 1,559. The *O*'s were: Mr. P. J. Cavanaugh (Ca), graduate student; Miss C. Comstock (Co), graduate student; Mr. F. L. Dimmick (D), assistant; Dr. L. B. Hoisington (H); Mr. H. S. Liddell (L), fellow; Dr. H. Sheppard (Sh), instructor; Miss R. Stutsman (St), graduate student; Miss A. H. Sullivan (Su), fellow; Mrs. M. J. Zigler (Z), and the writer (Zi). The observations were made in a light optics-room. *O* sat at a distance of 3.5 m. from the apparatus. The time of exposure was kept constant at 3 sec.

The first instructions read: "I am going to present a series of stimulus-cards, one at a time, on each of which a figure is represented. You are to observe it carefully, and when the curtain falls, to describe what you have observed." In order to evoke more explicit and fuller descriptions in attributive terms, the following instructions were subsequently used: "I shall show you a series of cards on each one of which a white figure is represented within a black frame and against a partial black background. Observe the figure carefully, and when the curtain falls describe so far as possible in attributive terms what you have observed. You need not report on the black background. You may, if you wish, draw an outline of the observed figure upon the blank provided. The time of exposure will be three seconds." The blanks provided for sketching were made from pad-sheets 7.5 by 12.5 cm. *E* pencilled in a border in such manner as to leave the area within the frame similar to that of the stimulus-cards.

Results.—The figures were correctly completed in tied imagery by all *O*'s on an average of 57+ % of the total number of presentations. The least successful *O* gave 40+ %, the most successful gave 84+ %. The unsuccessful reports are

of two kinds: figures with incomplete outlines, and observations in which *O* failed altogether to detect the more or less concealed figure. The "failures" comprise 15% of the total reports.

In one of the figures, the contours consist wholly of straight lines; in all the rest the outlines are mainly, if not wholly, made up of regular curves.¹⁰ Individual differences appeared in the nature of the imaginal limiting lines, as well as in the aptitude for finding the figures.

We may classify the facts which all *O*'s report, as differentiating the imaginally completed figure from its background (which is of the same uniform quality), under four headings.¹¹

(1) The outline is quite commonly given as an imaginary curved line, which may have either a lighter or a darker quality than the white background. Some *O*'s show a slight preference for the one or the other quality, while with others the reports are about equally distributed. The following are examples:

(a) *Lighter quality*.—"A very bright tiny line marks the figure out very clearly" (15 H 2).¹² "The figure was bounded by a very narrow white border, which was very bright" (3 L 5). "This figure is defined all around by a little bright white curved line" (4 C 14). "A narrow white line ran all around it. This was very bright white" (6 Ca 5). "There was a real white threadlike line forming the boundary of the figure" (6 Z 5).

(b) *Darker quality*.—"It was just as if the outline was painted by a small brush. I really saw the circles bounded by delicate black lines" (8 L 2). "There were narrow dark gray bands around the figures" (13 H 1). "The boundary was given in fine, cloudlike, but yet bright, dark gray" (3 L 7). "A very fine black line completes the figure outline" (18 Co 6). "This dark gray outline ran clear around both balls" (7 Su 9). "The outline was distinctly completed by a dark gray line" (13 D 2). "There was a gray line which ran up to the black border and down around the other side of the figure" (3 St 4).

(2) The figure is distinguished from its background by a difference in quality, which is given by all *O*'s as both lighter and darker than the background. Some *O*'s again show a rather marked preference for the one or the other quality. This difference is frequently reported together with the imaginal contour-lines; sometimes, however, the figure is marked off merely by an abrupt transition from its quality to that of the white background. The following are examples:

(a) *Lighter quality*.—"The figure is a much brighter white than the outside white" (10 Co 7). "The whole figure is much whiter than

¹⁰ Schumann was unable to observe 'subjective limiting lines' in figures with curved outlines; he observed them only in figures with straight boundaries. See I, 14.

¹¹ Schumann gives two modes of differentiation of the figure from its background: an imaginary limiting line; this may be a bright white line, which he calls a true 'subjective line,' or a black line (*reproduziertes Vorstellungsbild*); and qualitative change of the area of the figure. I, 12ff.

¹² The figure before *O*'s initial indicates the stimulus-card, corresponding with the numbers given above. The second number indicates the presentation of the particular card.

the grayish background" (8 Su 11). "The whole figure grew lighter and was surrounded by gray about the edges" (6 St 3). "It was slightly whiter than the background, which became light gray" (9 Z 3). "As soon as I saw the outline of the figure, it became brighter, and it had a gray outline" (13 Ca 4).

(b) *Darker quality*.—"A grayish film extends over the surface of the whole figure, and outside of the figure it is very white" (7 Co 4). "Its quality changed to a slightly grayer color, and the regions beyond the figure were brighter" (7 H 8). "The figure was of a dark gray and the background was white" (15 Ca 3). "As I looked at the 8, it became grayer than the outside" (7 Z 2). "That scroll stood out from its background very gray, and the surrounding area was definitely whiter" (10 Zi 5).

Several reports indicate that the figure assumed a lustrous quality. "After an instant there was a central part of the figure which became clearer, and the quality changed to a grayish lustre" (16 H 3). "Again the quality of the figure was a gray lustre" (13 H 4).

One *O* reports a case in which a free image helps to determine the quality of the figure. "I found myself endeavoring to identify that figure. The attempt to name it was very marked. First I said Circle, and then No. Kinaesthesia of shaking the head with this rejection. Then I called it an Indian pot. I do not know that I named it as such, but I identified it as such. I had a free image of a piece of Indian pottery which conformed with this. The figure now looked yellowish gray" (6 D 3).

Another *O* mentions a difference in the texture of the figure. "The figure is distinguished from the background by a difference in texture. The texture of the figure is thinner than that of the background" (18 Co 1). "Just a difference in texture distinguishes it. The figure is thinner" (4 Co 11). "It is a difference in texture that marks it off. The dumbbell is less dense. There is only this qualitative change that marks it off" (8 Co 6).

(3) Another fact reported by all *O*'s is that the figure assumes greater vividness than the rest of the exposed field. The black characters were vague and often unremarked. When the *O*'s undertook to sketch the figure, they were very often unable to place any black on the field; they declared that there was black there, but that they could say nothing about it.

"The figure became very clear and the outlying region became very vague. I could not say anything about the outlying parts at all" (6 H 4). "I did not notice the background as grayer; but I saw the figure as whiter, and knew the background must be grayer. The background was very very obscure" (8 Su 1). "The background was so unclear that I cannot report on it. The figure was the only clear thing" (14 Su 9). "I have no notion at all of the area surrounding the figure" (12 L 2). "The background disappeared when the figure was clearest" (10 Z 3). "The crescent stood forth in attention very vividly and all of the background was indistinct. When you get the figure it just sticks together as a whole and all the rest drops out. The attention-factor is the tremendous thing in the perception" (14 D 1). "There is a sort of spontaneity with which the attention goes to the figure. I absolutely lose all of the background" (15 D 3). "Soon it became a unitary figure, and the rest of the card was ignored. The figure was very very clear and I did not observe anything in the background" (14 Zi 2). "The figure was so clear that I saw nothing else. All of the background was unclear" (8 Zi 2).

(4) All *O*'s report that the figure assumes perspective, in addition

to the attributive changes already mentioned. The perspective, as we shall presently see, comes late in the temporal course and is correlated with objective reference of the figure.

"The outline was hardly so definite as a pencil mark. However, the circularity of the extent had for me the vividness of a natural perception, as the perception of a very white disc of cardboard hung against a slightly darker quality of background. This suggests the vividness of the perception" (3 L 6). "There is no line defining the figure, but it just stands off spatially, just as though a space of half a cm. were between the heart and the background. It is that that marks the figure off for me" (16 Co 1). "I had a distinct perception of separateness. The background seemed a quarter of an inch behind the white figure" (13 Co 1). "The figure became brighter and stood out in perspective, very markedly nearer me, with the darker background surrounding it in the distance" (9 H 5). "When the quality changed to this grayish lustre, the figure seemed an object set back behind the background" (16 H 3). "That figure came out in marked perspective toward me" (8 Z 5).—

Finally, two O's reported changes in intensity of the area of the figure along with changes in quality and clearness. Su gave this report very frequently. Asked just what she meant by intensity, she replied: "The figure becomes more glaring with increased intensity." H insisted that a figure, even if of the same quality as the outlying region, might assume greater or less brightness. The following are examples:

"When the white dumbbell was observed, it was more intensely bright. It was 'glary'" (8 Su 7). "This bowl was very white, but of rather low intensity. It was not glaring and not very bright" (6 Su 7). "The figure now became more clear and more intensely bright and was definitely outlined. I did not note much, if any, change in quality, but it merely became clearer and brighter" (8 H 7).

The O's distinguished three phases in the course of observation which culminated in a fully developed figure. First, under the influence of the instructions, which have set the O for perceiving a figure, comes a period of searching or *expectancy*. During this period O casts his eyes over the card and along the bits of black in the field, or fixates briefly certain parts of the white area in the expectation that a figure will emerge. Secondly, some portion of the white field between the black characters holds O's eye, and becomes the sensory basis for an abstract or plane-geometrical figure-meaning. The figure is not yet attributively differentiated, and there is no completion of the contours in tied imagery. Thirdly, by steady fixation of this area or by eye-movements around its periphery, the area of the figure becomes differentiated from its background in quality and vividness, assumes perspective, and is labelled by a concrete name, such as ball, sun, egg, pear, lemon, gold-fish bowl, Indian pottery. In the last two phases we have correlation of certain sensory moments with a definite type of meaning. Their distinction is especially significant in that the instructions did not impose, or even suggest, the task of reporting temporal sequence.

All ten O's definitely indicate these three phases, and their characterisations are essentially the same. This does not mean that all phases, and the two last in their dual aspect of process and meaning, were reported in every observation; we have already said that the cards offered a sort of puzzle, which was not always successfully solved. There were various omissions and short cuts. In the 15% of "failures," in which no figure at all was found, phase I only was represented. There was, in fact, a certain percentage of observations in which all three phases were noted; there were cases in which phase I was omitted, while both aspects of the other two phases were fully given; and a few reports by all O's were cut short at the end of phase II, so that processwise the figure was not completed in tied imagery, and was not differentiated in quality, clearness and perspective from the outlying white field, and meaningwise it failed to take on objective reference and was not labelled with a concrete name. The accompanying table shows the percentages of such complete and undeveloped reports for all O's.¹³

O	Total Presenta- tions	Total Complete Reports	%	Total Undeveloped Reports	%	Combined %
Ca	144	9	6.2	11	7.63	13.83
Co	270	9	3.3	29	10.74	14.04
D	90	8	8.88	4	4.44	13.32
H	144	33	22.9	6	4.16	27.06
L	83	7	8.43	12	14.45	20.88
Sh	216	13	6.01	13	6.01	12.02
St	180	15	8.3	11	6.11	14.41
Su	216	22	10.1	15	6.94	17.04
Z	108	10	9.26	5	4.63	13.89
Zi	108	19	17.5	7	6.48	23.98

The following excerpts are descriptive of these phases.

Phase I.—"Just the total white field. That peculiar organic set that makes one look for a figure. The whole card was not equally clear at all times, due to rapid shifts of fixation" (9 H 4). "There was first a tendency to explore, and the whole card was explored, more or less. I was attending to the white parts and they were clearer than the black" (12 H 8). "I keep trying to see something in the center but cannot do it. There must be some figure among the black dots. I feel that they partly outline some figure, but there is no meaning there" (17 Su 7). "Inside of this triangular area were some black figures. Inside of them I was hunting for a white figure"

¹³ The remaining reports are distributed among the following classes: (1) 'condensed' reports, wherein phase II is omitted, and there is an immediate jump from phase I to phase III; (2) 'incomplete' reports, from which one or both aspects of either phase II or phase III are omitted; and (3) the group of 'failures.'

(17 Su 12). "I had a set for a white figure, but when I first saw the card it was only black on white. . . . So I continued to look more actively. . . . I think there was a good deal of eye-movement here. When I do not get the figure at once my eyes move from one black spot to another to get a figure" (9 Co 11). "I just looked all around among the ends of the black lines to get a figure that I could put a meaning to" (14 Sh 8). "Before the circles came in, my eyes were moving around over the card trying to get a white figure. I then noticed the outline of the edges of black and moved along it and the figure appeared" (13 Ca 3). "I did not get the figure until just as the curtain dropped. My fixation and attention jumped around all over the possible parts of the pattern defined to find a figure" (8 D 4).

Phase II. (1) *Process*.—"Then a shift and I saw two circular areas set in between the black lines. At first these had no particular character except they were the clear things" (7 H 5). "Then a bit of the card catches you and stops the exploration. The figure is not completed or marked out in this stage. Just this bit catches the attention" (13 H 7). "I saw a white sort of a figure. It was only moderately intense and clear. There were white surfaces at the sides of the figure that were of no difference in quality from the figure itself, but they did not seem to belong to the figure. I do not know what that figure is, and don't know that it was marked off" (12 Su 12). "I don't believe this figure was marked off at all except by the black lines, but still the white in the center seemed to suggest a figure" (11 Su 6). "This figure is hard to describe because I did not have time to get it completed. There was continuous eye-movement over it in an attempt to have it take outline and mean something. But the figure seems to have a rather definite extent" (12 Co 12). "The circle is separated from the background only at the ends of the black lines. In between them it is not marked out. It is as if it were about to come out, but it did not before the curtain dropped" (3 Co 7). "The black strips are so broken that a sort of a circle is formed in the center. But I did not get the outline around the circle where there were no black strips" (2 Sh 3). "I just look at that shape, but I cannot see the outline or any changes to mark off the figure. I just did not know how to finish the figure" (15 St 3). "There is just a square shape of white there, but it is not at all different in quality from the rest" (1 St 6). "As I moved my eyes along the black lines I saw a white 'shape' in the center. It suggested circle, but I had to move my eyes around it to get it to come out definitely" (13 Ca 6). "At first that just looked like a figure of white. It was just a flat shape of white, but was not definitely outlined yet" (8 Z 4). "I saw a perfectly white figure suggested by the black lines. But all the white of the whole field was of the same whiteness" (14 Z 2).

(2) *Meaning*.—"Something about this gives a hint of meaning, but the meaning seems to be indefinite, and I continue to sweep over the figure trying to verify the partially-accepted meaning. There is tension or strain in the throat which means suspended judgment, and I move to verify my judgment" (14 H 7). "The figure-meaning came before the thing became a definite or particular figure" (13 H 7). "At first, when there was just a flat surface and it was not outlined, the figure did not mean much. It did not represent any known object" (18 Su 8). "This was a figure, but it did not have a meaning that I could name. But it meant a figure because there were not just black lines there" (12 Su 4). "It seems to have a definite extent, but is not marked out by the usual lines, and does

not mean anything except a white figure-shape" (12 Co 12). "At first this central area was vague and suggested that it might be circular or slightly elliptical in shape" (2 L 1). "At first that figure was merely a 'design' and took on no particular meaning" (11 St 3). "That shape does not remind me of anything, except that it is just a shape. I cannot name it" (15 St 3). "I saw a pattern of white among the black. I call it a pattern because it is not what I mean by a figure. I don't have any tendency to name this figure and a figure has a name. This is just a white pattern of different parts" (7 D 1).

Phase III. *Process and Meaning*.¹⁴—"The whole figure became clearer and the surroundings obscure. It also assumed convex perspective" (18 H 6). "The figure became of a different quality and was very bright and had perspective. The rest of the field was quite obscure. It was a beautiful *marble* now" (17 H 8). "Very quickly it popped out very white and the background was quite submerged. The black of the background was quite obscure. The figure looked like a real *crescent* now" (9 H 7). "When these changed to little *balls*, they became whiter and more intense and clearer. Little dark-gray narrow line surrounded them. They changed very quickly" (13 Su 6). "This was a *globe to hold goldfish*. It rounded out and had depth. It meant a real globe instead of the flat figure that preceded" (2 Su 5). "That *electric light-bulb* was of a slightly greenish gray and took on marked depth. Where the black lines do not meet at the top, I extend the greenish gray surface so that I make a tip for the bulb. The tip is the same color as the bulb. The contour of the bulb is very distinct now" (6 Co 4). "On a second look it looked like a *hammock* instead of an oval figure. There was a visible gray outline around it. It had a very definite dividing line" (15 St 2). "Then it meant a *vase* to me. The vase was outlined. The disc which was first suggested was not outlined; but when the figure meant *vase*, there was distinct white outlining it. The surface of the *vase* was gray" (6 Ca 7). "Then the figure stood out at me. It was definitely and completely outlined all around. My images were rather a gray strip just outside the contour of the figure. I named it *battle-axe* then" (11 D 1). "As I looked at it more it appeared to be a *barrel*. It came out in perspective and I saw three hoops of grayish quality running across the *barrel*. This was very clear and looked like a real *barrel*" (3 Z 3). "Soon it changed and looked like a *football*. It was gray, especially on the right side, and the gray surface shaded up the edge of the figure prettily" (4 Z 3).

The general results of this section may be summed up as follows:

1. Partially outlined figures may be completed imaginally by curved as well as by straight contours. The figures thus completed are differentiated from their identically colored background (a) by imaginal lines of tied imagery completing the contours, (b) by a change in the quality of the figure-surface, (c) by an enhanced vividness, and (d) by perspective.

2. Three stages in the temporal course of these observations could be distinguished: (a) a phase of *expectancy*, wherein O

¹⁴ It seems unwise to separate the descriptions of meaning and process in this phase; but the object-meaning is italicised.

is set for the appearance of a figure; (b) a phase of *abstract* form-meaning, which has correlated with it a definite sensory datum (this datum gives merely the suggestion of form; it is not marked off from the background by attributive differences other than vividness); and (c) a phase of *concrete* or *objective* meaning, in which *O* labels the figure with a concrete name. A wealth of sensory processes is correlated with this object-meaning; they are subsumed under (a) tied imagery, (b) qualitative changes, (c) change in the distribution of vividness of parts, and (d) perspective.

SECTION III

In these experiments a plane-geometrical figure, *e.g.*, a square outlined in black on a large white field, was presented to *O*; and, while the observation was in progress, this figure was gradually changed to another, *e.g.*, an oblong. We hoped to determine the ultimate observational moments characteristic of various plane-geometrical figures.¹⁵

Six stimulus-cards were used. Five operated upon the principle of elongation: 1 square-oblong, 2 circle-flat sided oval, 3 diamond-hexagon, 4 plus sign-cross, and 5 multiplication sign-double arrow. The sixth card allowed the vertical sides of a square to fall together (at the same time that the upper horizontal side was concealed) to form a triangle. The dimensions of the smaller or unelongated figures were 5.5 cm. in each direction; either dimension could be increased by distances up to 10 cm.

These compound cards were presented in a large picture-frame exposure-apparatus. A door at the back held the cards firmly, but not tightly, against the plate glass. A groove mortised in the top of the frame, flush with the inner side of the plate glass, allowed the hinder card to move upward and downward. The movement was effected at a uniform rate by the pull of a running kymograph. The rate, empirically determined as favorable for the observations, was 10 cm. in 8 sec.

The time-orders were roughly equated; *i.e.*, the elongated figure was shown first in an exposure about as often as the unelongated. The square-oblong figure was presented to all *O*'s on an average of 15 times with each direction of movement; the other figures averaged only 9 times in each direction.

The 7 *O*'s were Ca, Co, D, H, Su, Z and Zi. *O* was seated

¹⁵ Perhaps Schumann also made the first step in this direction. His characterisations, however, are grossly perceptual and associative. See I, 15 ff.

6 m. from the apparatus; at this distance he could not perceive the line of demarcation of the constituent cards. The work was done in a light optics-room. The following instructions were used throughout: "I shall show you a card on which a figure is represented in black. Observe the figure carefully and, when the curtain drops, report what you have observed." The total exposure-time was 12 sec.; the first figure of an exposure was shown stationary for 2 sec. before the movement (which consumed 8 sec.) began, and the second figure was also shown for 2 sec. in the final position before the exposure terminated.

The main series were taken with the frame in the vertical position. In an extra-series with H the apparatus was turned on its side, so that the square, when elongated, became a horizontal oblong. The same technique and instructions were employed.

Results.—A certain period of training was necessary before the O's fell into the strictly "descriptive" attitude. During the earliest sittings *common-sense* reports were the rule: "The oblong is longer than the square;" "The oblong is longer in one direction while the square is the same in both directions." Very soon, however, the O's realised the inadequacy of such reports; and cast about for other criteria of difference between the figures. The next mode of differentiation came by way of an *empathic* tendency: as the figure was pulled upward, there were reports of sensory experiences of "lightness" or of "expansion;" when the movement was downward, pressure on the head and general "compression" were reported. These experiences all reduced to sensory or imaginal kinaesthesia. One O (Su) began with a clean-cut *objective* attitude. The long vertical sides of the oblong appeared, with upward movement, to stretch and become narrower, particularly in the middle region; and with downward movement to be compressed, to thicken and to bulge out.

After a short period of practice the seven O's passed by way of these *common sense*, *empathic*, or *objective* attitudes to the attitude of strict *psychological observation*. The instructions were not altered in order to attain this attitudinal shift; it is probable that the observations of the preceding section exerted an influence which favored the transition. Two O's, who came into the experiment for this series only, and without the previous experience, never passed beyond the *empathic* or *objective* attitude.

There was a tendency with all O's to report an initial exploratory phase, from which the meaning and the attributive marks of the figure emerged. We merely mention these re-

ports; nothing significant is to be gleaned from them except that any part of the figure may first become clear, and may thus be the starting-point of exploration. At the end of this phase the complete figure is in focus. The direction of exploration was usually from left to right; most commonly it began at the lower left corner of the field, and went upward and to the right.

We now take up the stimuli in order, and report the enarcterizations of the figures.

Square-vertical oblong.—The square was in practically every case described as attributively alike in all its parts.¹⁶ D reported several times that the corners of the square were the clearest parts; he was, however, not very sure of the observation. The oblong, on the other hand, was characterized by differences in distribution of attributive characters; the longer sides were described by all O's as blacker, clearer and broader. Two, H and Su, also report a higher intensity. The short sides of the oblong were described as grayish, vague, and narrower.

H and Co frequently reported an *empathic* difference between these figures. H stated that the square had a "stability" or "compactness," which he found based upon sensory and imaginal processes in the chest or throat. Co reported a "lack of balance" in the oblong, based upon imagery or sensations of pressure in chest or shoulders. The "objective" attitude of Su to the oblong has already been referred to.

Circle-oval.—The circle was described by all O's as attributively uniform in all parts, while the oval was just as universally characterized as blacker, clearer and more extended on the two longer sides.¹⁷ He also reported empathic "compactness" or "stability" in the circle. At times Su and H reported an *objective* attitude toward the circle. When regarded as object, some arc of the circle, usually that upon which it rested, or if it rolled the side toward which it rolled, was qualitatively blacker, clearer, more extended and more intense. These objective characterisations usually followed in time the observation of the figure under the "form" attitude.

Diamond-hexagon.—For the most part the diamond was described as attributively uniform in all parts. Several O's, however, went further in analysis. Co reported the four points clearer and blacker. For D the two vertical angles were the characteristic parts. Ca reported that the figure divided horizontally, and that the upper half was usually attributively enhanced.

In the hexagon, as in the oblong and the oval, the two long vertical sides were attributively enhanced. Co reported an *empathic* "unbalance" in the hexagon. She remarked several times: "I was afraid it would fall over."

Plus sign-cross.—For the most part the plus sign was described as

¹⁶ Schumann reports that in the square all four sides are uniformly combined (*gleichwertig verbunden*); in the oblong, the two longer sides obtrude in consciousness (*hervortreten oder auffallen im Bewusstsein*) and are more closely combined (*inniger verbunden*). See I, 15 ff.

¹⁷ Schumann states that in the circle no parts obtrude, while in the oval the two sides which give it its longer dimension obtrude and combine more closely. See I, 22.

attributively uniform in all parts.¹⁸ Analysis was carried further in later observations, in which the horizontal arm bore enhanced attributive marks, and the vertical arm was grayish, less vivid, and narrower. Co showed the *empathic* tendency by noting "solidity" or "balance" in the plus sign.

In the cross, the long vertical line was universally described as attributively predominant. Co also reported a "feeling of unbalance."

Multiplication sign-double arrow.—The times-sign¹⁹ was at first described as attributively uniform, and the long vertical line in the arrow was enhanced in all attributive respects. Toward the last, Ca and De reported a step in analysis of the times-sign: the upper or lower half of the figure was enhanced. Ca also reported, as did all the O's before the series ended, that one of the diagonals, usually the lower left-upper right, became blacker, clearer and broader as a whole. D sometimes took an objective attitude toward the arrow, and in these instances described one of the arrow points as attributively heightened.

Square-triangle.—As we have already said, the square was observed as attributively identical in all parts. The triangle, however, was characterized by enhancement of the apex and the two sides forming it.²⁰ The base line was very commonly described as grayish, and sometimes as quite vague.

Square-horizontal oblong.—H reports that the upper horizontal side assumes attributive predominance over the lower. Sometimes the upper side alone, but usually both of the long horizontal sides, are attributively heightened.

These reports show that, even after the "descriptive" attitude had been assumed, the O's were able to take account only of the more obvious descriptive features of the figures. We therefore had recourse to another mode of presentation.

SECTION IV

By the procedure of Section III we were able to present only one figure, *e.g.*, the square, with its corresponding elongated pattern, *e.g.*, the oblong. We now arranged conditions whereby any figure could be presented with any other, *e.g.*, the circle with the square. We hoped by this variation to enable the O's to carry further the analyses previously begun.

The stimulus-cards carried 12 figures, accurately drawn in black on white: 1 square, 2 horizontal oblong, 3 triangle, 4 vertical oblong, 5 tilted square, 6 circle, 7 oval, 8 plus sign, 9 multiplication sign, 10 horizontal rhombus, 11 horizontal

¹⁸ Schumann reports that the two arms of the plus sign combine equally and that no parts obtrude. He did not use the cross figure. I, 20.

¹⁹ Schumann observes that any two legs of the times-sign lying symmetrically to the vertical or horizontal, preferably to the former, obtrude and combine more closely. He does not note the enhancement of a diagonal, which Ca first reports and which all O's get in the later work. I, 20.

²⁰ Schumann notes that the base of the triangle is of less observational significance. He states that the two sides forming the apex of the triangle obtrude and combine to a greater degree of unity. I, 20.

diamond, and 12 vertical diamond. The maximal length of any figure was 3 cm. Figures of the same magnitude in both dimensions, *e.g.*, square and circle, measured 2 cm. in each dimension. The figures were shown, as by the method of paired comparisons, in a Dodge tachistoscope.²¹ The distance of the stimulus-card from O's eye was 38 cm. The shift from the first exposure field to the second was affected instantaneously by a swinging pendulum; the brightness of the two fields was sensibly the same.

The five O's, Co, H, Su, Z, and Zi, had all taken part in the work of Section III. The following instructions were used throughout: "I shall present to you two figures in succession. You are to observe them carefully, and at the end of the exposure to report in strictly psychological terms what you have observed." The time of exposure was regulated by a silent metronome; a complete swing consumed 2 sec., which was the time between the "ready" signal and the first exposure. Each of the paired figures remained under illumination for 2 sec.

A complete comparison-series comprised 66 observations; a complete series for all O's, 330 observations. We performed three series. The experimental conditions remained identical, except as regards a fixation point. In the first series, there was no fixation mark; after the ready-signal O was simply staring into darkness, when suddenly the first figure appeared. In the second series we used two fixation points on every card. These were placed horizontally just outside the boundaries of the figures; they were not perceptible during the period of illumination. In the third series the two fixation points were set vertically. Since the results show no significant differences, we do not distinguish the three series in what follows.

Results.—Certain figures brought out stable and uniform descriptions; most definite were the plus-sign, the oval, and the two oblongs. The square and tilted square proved most baffling, and their analyses were reported with less assurance than those of the other figures.

Square.—This figure was most frequently described, under the form-attitude, as uniform in quality, clearness, extent, and intensity in all parts. When the square took on the "object" meaning, Co stated that the base line was increased in all attributive respects, while H described the base line as more vague, grayish, narrower and less intense; the other three sides were uniform. There were occasional reports of a brief initial stage in which two parallel sides were clear and definite, and the other two very indefinite; in this stage,

²¹ R. Dodge, *An Improved Exposure Apparatus*, Psychological Bulletin, IV, 1907, 10 ff.

however, the form-meaning was that, not of a square, but of two parallel lines, with two grayish and vague cross lines unrelated to the figure, and usually out of its plane. There were also early reports in which the square figure had the meaning of oblong; *O* then described two parallels as blacker, clearer and a little wider than the others.²²

Horizontal oblong.—The longer parallel sides of this figure were described as blacker, clearer, broader and more intense than the shorter sides. These marks usually characterised the lines as wholes, although *Su* sometimes reported that they were blacker, etc., in the center, and graded off attributively toward the ends; the ends were never so vague, however, as the shorter sides of the figure. For the most part the two more pronounced sides were equally enhanced; but toward the end two *O*'s tended to see the one side slightly predominating over the other. For *H* the upper side was somewhat more pronounced, while with *Co* the base line was preferred.

In all the work of this section, the differences of quality and clearness were most obvious. All *O*'s reported changes in extent, but less frequently, and with less definiteness of assertion. Differences of intensity were reported only by *Su* and *H*.

Triangle.—The two sides forming the apex were attributively enhanced, and the base line was vague and grayish. Usually the sides were enhanced as wholes, but sometimes the parts about the apex were more pronounced. *Su* and *Co* reported occasionally that the base line was blacker and broader: in these cases the meaning of the figure had changed. *Su* stated that she saw just a bold black horizontal line with grayish legs projecting away from it; the lines formed no definite figure, and did not carry the meaning of triangle. *Co* also stated that the figure as thus seen did not mean "a good triangle." We shall see presently that these *O*'s show a preference for horizontal lines.

Vertical oblong.—The two longer parallel lines were described as clearer, blacker, broader, and sometimes as more intense than the shorter horizontals. Usually both of the longer lines were equally predominant; toward the end, however, *Co* tended to report the one or the other, usually the left, as the more pronounced. Usually, again, these lines were enhanced throughout their length, but in a few instances only about two-thirds of their extent was changed.

For *H*, as we have already seen, the horizontal oblong is dominated by its upper side line; in the vertical oblong the two longer sides are equally enhanced. *Co* reports a predominance of the base line in the horizontal, and of the left vertical side in the vertical oblong.

Tilted square.—Usually two parallel sides assumed attributive prominence in this figure; frequently the upper or lower, and more rarely the right or left half became more marked; a few reports indicate the lateral angles as the characteristic parts; and a few that the figure is attributively uniform in all parts. Thus on the side of process this figure is variously described, even by the same *O*'s. But a different meaning is correlated with the differences of description. When two parallels, usually the lower left and upper right, were most marked, the *O*'s often remarked that the figure seemed slightly longer in the direction of these parallels; it meant a distorted diamond or

²² Schumann found that observers could voluntarily favor any two sides, particularly the verticals of a square; and that, when two sides were thus preferred, they united more closely and the figure was no longer a square but an oblong. II, 16 ff.

parallelogram. With the one half outstanding, the figure meant a diamond, two triangles, or two V's put together. The horizontal division, into an upper and a lower half, was largely preferred. When described as uniform in all parts, the figure meant a square. When the lateral angles with a small portion of the lines forming them were the characteristic parts, the meaning was that of a diamond. In a few reports this last interpretation included an "objective reference;" a tied image, whiter or grayer than the background, then formed an observable link between the angles.

Circle.—The circle, under the form-attitude, was reported as uniform in all parts. Frequently the figure took on an "object" meaning; this sometimes followed the "form" meaning, sometimes came at once as the figure was exposed. In these cases, as in our previous work, certain parts of the figure were attributively differentiated: if it meant a rolling hoop, an arc of about 30° on the side toward which it rolled was enhanced; if it meant a standing wheel or hoop, it was more marked along the arc on which it appeared to rest.

The attempt to find an attributive basis for the difference between circle and square proved unavailing. There were a number of reports of an empathic difference: the circle was characterised by a "smoothness," which the square lacked, and the square in distinction had a characteristic "abruptness." These empathic data reduced, so far as the O's could tell, to imagery of eye-movements about the outlines of the corresponding figures.

Two of the regular O's, as well as Dr. Titchener, who observed in this series, reported a tendency for the circle to expand laterally; the arcs on either side were then somewhat enhanced attributively.

Oval.—The two long sides of the oval are attributively enhanced, and the short end-arcs are less marked in all attributive respects. For the most part both long sides are equally enhanced; Co and H, however, noted a tendency for the base and upper side respectively to assume a slight predominance.

All O's differentiated the oval from the oblong by the fact that, in the latter figure, the enhancement extended uniformly the whole length of the longer sides, while in the oval there was a gradation from the most marked attributive increase at the center outward toward the extremes of the figure. The O's were unable to specify a precise point at which enhancement ceased or began. Moreover, most O's declared that the round ends of the oval, even though of a very low degree of clearness, were more essentially characteristic of the oval figure than were the short sides of the oblong for that figure. In other words, the short sides of the oblong were less clear than the round ends of the oval. One O, Su, frequently reported that the short sides of the oblong were unobserved, while if the oval was to be apprehended as such the round ends must be perceived.²⁸ An empathic difference was also noted; the oval was characterised by a "smoothness" and the oblong by an "abruptness." These characterisations again appeared to reduce to imagery of eye-movement.

Plus-sign.—In this figure one of the axes was attributively differentiated from the other. All O's except Z described the horizontal axis as blacker, clearer, and wider. Z reported the vertical axis

²⁸ Bühler finds that two adjacent sides, usually the left and the upper, are essential parts in the oblong; and that the limen of proportion of rectangularity is not essentially heightened by omission of the right vertical and lower horizontal sides. Bühler, K., *Die Gestaltwahrnehmungen*, i., 1913, 182 ff.

enhanced, just as constantly as the other *O*'s reported the horizontal. Most *O*'s asserted that the parts of this figure are more obviously differentiated than those of any of the other figures. A very stable attitude and a steady and definite type of report were soon acquired. The differentiation of parts was, indeed, so pronounced that one *O* believed the horizontal line to have been drawn broader and heavier. This statement was made a number of times; and at the close of the work the stimulus-card was accordingly handed to *O* for closer scrutiny. Holding it in the usual position, she exclaimed: "I told you the horizontal line was drawn heavier!" Asked to turn the card 90°, she was amazed to discover that the originally vertical line, which in the normal position was very vague, assumed just as great predominance over its rival as this, the originally horizontal line, had held before.

Times sign.—The parts of the times-sign which were characterized by more marked attributive moments were somewhat variable. Most commonly one of the legs, usually the lower left-upper right leg, was attributively enhanced. There were also numerous reports in which the figure divided into an upper and a lower half; usually, one half was then attributively increased. There were a few reports in which the figure divided vertically, and the left half was the more characteristic.

Rhombus.—In this figure either the two parallel horizontal sides, or the obtuse angles with portions of the lines forming them, were the attributively marked parts.²⁴ All *O*'s reported that, when the horizontal parallels were the marked parts, the correlated meaning was that of parallelogram or rhombus. In this situation the oblique sides were very low in clearness. *H* again showed his general tendency to give the upper horizontal a slight predominance over the lower; both, however, were heightened more or less. When, on the other hand, the obtuse angles were the heightened parts, the figure-meaning was that of diamond. The shift of meaning with definite alteration in descriptive content was extremely constant in this figure, and was brought out by all *O*'s. Several *O*'s reported a tied image connecting the two angles in the diamond; the image was qualitatively either brighter or darker than the background of white, and played a part only when the figure had assumed an object-reference.

Horizontal diamond.—All *O*'s found a good deal of variation in the diamond-figures, and no one part acquired a steady preference or predominance. However, with the shifts in descriptive content we have a fairly definite correlation of shifts in meaning. The portions of the lines forming the acute angles were very commonly enhanced, and the meaning of the figure was then definitely that of diamond. When this particular content assumed an object-meaning, a tied image often connected the angles. Again, two parallel sides of the figure were often enhanced, when it took on the meaning of a sort of parallelogram. The figure was observed as longer in the direction of the concerned parallel sides. At other times the figure divided horizontally, and the upper half was usually described as attributively increased. The meaning in this case was given as diamond, with frequent specification of two triangles with their bases juxtaposed, or

²⁴ Schumann found no outstanding feature in this figure. He says that, when two sides of the figure are in the horizontal direction, all parts are equally combined, just as in the square. Only the differences in the angles differentiate the rhombus from the square. I, 20.

two V's put together, the one of which was of a slightly enhanced attributive status.

Vertical diamond.—Here again either the portions of the lines forming the acute angles, or two parallel sides, were attributively heightened. In the former case the figure had a definite and positive diamond-meaning, and tied imagery played its usual rôle when the object-meaning supervened. When two parallels were the outstanding parts, the meaning was that of a sort of parallelogram or distorted diamond. There were also a few reports in which the figure divided into halves, as in the case of the horizontal diamond.

The general outcome of the foregoing work may be summarised as follows:

1. Schumann's general statement that certain parts of plane figures obtrude in consciousness and combine more unitedly than the rest is shown to have an analysable sensory basis. The sensory content assumes a definite pattern of distribution appropriate to particular figure-meanings, and may be described in various attributive respects, *viz.*, quality, clearness, extent and intensity.

2. When a figure has an unmistakable meaning, there is a stable pattern of attributive distribution. When the meaning is variable, there is variability of the enhanced attributive pattern corresponding with the various shifts in meaning. We may thus account for the perception of different forms in the same stimulus, and the perception of the same form in different stimuli. The tilted square, *e.g.*, when observed as a diamond, has the attributive characterization of the diamond; and, when observed as a square, is described as the square.

3. If a figure acquires an object-meaning, there is a change in the perceptual content. Tied imagery often plays a rôle in the object-perception.

4. The figures may be distinguished either psychologically, as just indicated, or empathically. Empathic is akin to naïve or common-sense differentiation, and is consequently reverted to when psychological observation is most difficult.

5. Four of our O's showed a preference for the horizontal direction; the other O as strongly preferred the vertical. Hence there are individual differences to be reckoned with in observations of this kind.²⁵

SECTION V

Our previous experiments have shown, in various contexts, that the same physical stimulus, under repeated presentation,

²⁵ Schumann implies that both the horizontal and the vertical directions are more important than the oblique; IV, 161 ff. He also remarks that lines which lie symmetrically to the vertical axis are more apt to be grouped together as a unity: I, 18 ff.

may set off a variety of meanings, and that the psychological experience underlying the observation of the figure differs as these meanings vary. In the instance of the rhombus, *e.g.*, the meaning either of parallelogram or of diamond might emerge, with corresponding descriptive difference. Moreover, we have found a descriptive difference for the same figure taken under the "form" and the "object" attitudes.

These results led us to seek conditions which should allow a still greater flexibility of meaning with observation of one and the same stimulus. We relied especially upon the arousal and influence of tied imagery. We therefore prepared figures whose outlines were indicated by widely discrete white pin-heads set on a large black background. The instrument employed was Münsterberg's *Augenmassapparat*.²⁶

We performed four experimental series. The first two were very short, and served as a continuation of the work of the preceding sections. In the first series a figure, *e.g.*, a square of 6 cm. side, was indicated by four white pins; the two lower pins were fixed in the black broadcloth, and the two upper were carried on a horizontal rider glued to the threads which stretched vertically in front of the broadcloth screen. By operation of the thumb-screws this figure could be changed, laterally into a rhombus, and vertically into an oblong. In like manner the diamond could be reduced to a triangle and conversely, and the triangle into a straight line. The *O*'s were those of Section IV, and their instructions were unchanged. They sat at a distance of 5 m. from the apparatus.

In the second series the two upper dots of a square, outlined as above, were moved obliquely upward; thus the figure expanded as it lengthened upward, and took the shape of a truncated triangle or wedge. This change was accomplished by means of pulleys placed along the top and bottom edge of the broadcloth screen, and belts of narrow black braid running obliquely around the pulleys. The *O*'s and the conditions of experimentation were as in the first series.

In the third series we adopted a procedure which gave greater scope for multiform meanings with the same stimulus-pattern. We used the two stimulus-patterns suggested by Bühler,²⁷ the square and tilted square, each indicated by four white dots. During the first sitting the one of these patterns (the tilted square for Co, Su and Z, and the square for H and Zi) was presented for a certain period of time, during which *E* called out in succession the names of various figures

²⁶ See E. B. Titchener, *Experimental Psychology, Instr. Quan. Manual*, 1905, 210.

²⁷ Bühler, K., *Die Gestaltwahrnehmungen*, I., 1913, 26.

which *O* should find outlined by the dots. The figures required in the tilted square were: tilted square, right oblique parallels, plus sign, division sign, left oblique parallels, circle, dotted *V*, and *Z*; those demanded in the square were: *X*, square, *N*, vertical parallels, *Z*, *O*, horizontal parallels, and *M*. These figures were called for at successive intervals of 4 sec. Under observation, the figures were completed in tied imagery. The instructions read: "I shall expose several uniform white dots, which are regularly arranged on a large black background. I shall then ask you, at rather brief intervals, to observe these dots as forming the framework of a series of figures. It will be your task to observe the figures as called for; and after observing a short series of them to describe each one. If in your subsequent description you are unable to recall the order in which they came, I shall be ready to prompt you."

At the next sitting the other pattern was shown (the square to *Co*, *Su* and *Z*, and the tilted square to *H* and *Zi*), with the instruction that *O* observe as many different figures as possible. The exposure continued until *O* indicated he could find no more figures. The following instructions were used: "I am going to present several uniform white dots which are regularly arranged on a large black background. Your task will be to observe as many different forms as you can, and every time you observe a new form to call out what it is. The exposure will continue until you are no longer able to get a new form. When the exposure has ended, you are to describe the forms observed as carefully as you can. If you cannot recall the order in which you observed them I shall be ready to prompt you."

In the fourth series we attempted to provide stimulus-patterns which should represent different degrees of difficulty in the suggestion of a meaning. We made a set of eighteen stimulus-patterns, which we supposed would give *O* roughly three orders of difficulty. There were six stimuli in every order, *viz.*: (1) *patterns of concrete objects*, light bulb, bell, fork, coat of arms, pennant, hand mirror; (2) *patterns of stellar constellations*, Cepheus, Orion, Pleiades, Cassiopeia, little dipper, sickle; and (3) *patterns of plane geometrical figures*, in which an *extra* pin was placed so as to disturb or break up any tendency to complete the figure,—triangle (in), triangle (out), square (in horizontal), square (out horizontal), square (in vertical), square (out vertical). The extra dot was placed at random by *E* in any one of the spatial directions indicated. These 18 stimuli were arranged in a single series with regular distribution of type. The time of exposure, determined by

O, was measured by *E* with a stop-watch. The three O's, Co, Su and H, worked under the following instructions: "I shall show you a cluster of white dots on a large black background. These dots are so arranged as to outline a figure. You are to search for the figure and to signal its appearance by saying 'Now.' Then you are to describe, so far as possible in attributive terms, what you have observed."

Results.—In the first series the descriptions of the oblong, rhombus, triangle, etc., show the familiar psychological features. The figures tended to complete their outlines in tied imagery, which was clearer, qualitatively more enhanced, and of more definite limits, in those parts which have already been reported as characteristic of the particular figure. Most commonly this imagery was a dark gray, varying in degrees of qualitative difference from the deep black background. Some O's tended to report the total area inclosed by the dots as either blacker or grayer than the outlying background. In such observations the limits of the qualitative differentiation were more cleanly cut on the psychologically characteristic sides of the figure; the limits on the more vague sides (*e.g.*, the short sides of the oblong) were described as "fuzzy," "stringy," "indefinite," "fading away into vagueness." Thus this series with incompletely outlined figures confirms the results obtained with figures whose outlines were continuously drawn.

In the second series the O's tended to hold rather firmly to the "form" attitude. Several stated that it was not necessary to obtain a concrete meaning, although the more pregnant imagery was correlated with such objective references. The oblique sides of the elongated figure were universally described as characteristic; the top and bottom were seldom definitely outlined. These oblique sides were given (1) by a qualitatively lighter or darker tied image, and (2) by a sharply delineated edge of the qualitatively different surface inclosed by the dots. In such observations the figure was usually named a truncated triangular shape. There were occasional reports in which the figure assumed an object-meaning, when it was named vase or pyramid. With the meaning of vase the bottom of the figure was also closed by a definite imaginal line similar to those forming the oblique sides; the top remained open. With the pyramid-meaning the characteristic oblique imaginal lines projected beyond the white dots outward to a point where they intersected. The entire surface within these oblique limiting lines was qualitatively differentiated from the outlying field of black.

In this series, as we have said, the O's declared that it was

unnecessary to assume the object-attitude, and tended more and more to remain in the form-attitude. Since we have previously found a greater richness of attributive characterization and a more prominent rôle of tied imagery under the object-attitude, and since our goal here was variability of meaning with identity of stimulus, we thought it advisable to change the procedure, in order to bring the *O*'s, if possible, to look for the object-meaning.

The significant outcome of the first part of the third series is that, on the demand of *E* for the eight different meanings from the same stimulus-pattern, *O* noted corresponding phenomenal changes in every figure. The imagery of a prior meaning broke up and redistributed itself, thus furnishing a new sensory basis for the new meaning demanded. Eye-movement played a part in determining these shifts of imagery. All *O*'s stated that, where the meaning was more "real" and objective, the imagery was more definite and attributively heightened. Roughly, three degrees of definiteness of imagery were indicated. With all *O*'s the parallel lines called for were reported as of the lowest degree of definiteness, and the meaning was uniformly stated as abstract. Perspective was involved in a few reports in which the figure-meaning was concrete.

In the second phase of the same series the figures observed depended more or less upon the ingenuity of *O* in contriving new figure-meanings. Co reported 10, Su 17, Z 12, H 10 and Zi 14 figures. The descriptions forcibly confirm our conclusion that concreteness of meaning is correlated with heightened imaginal processes. The reports of concrete meanings (cornucopiae, hourglass, hoop, earth-on-axis, cross-in-perspective, wheel, end-of-crystal), showing definite objective reference, are always and for all *O*'s attended by description of the best-marked imagery. Most *O*'s again indicated three degrees of definiteness of imagery; Su and Zi gave four. The accompanying summary shows the figures reported, at the different degrees of definiteness of imagery, by the different *O*'s. It is clear that the more concrete meanings fall in the more definite, and the more abstract figure-meanings in the less marked classes of imagery.

In the last series the ease with which *O* obtained the figure, as measured by his reaction-time, turned out roughly as we had anticipated in the construction of the stimulus-series. The "constellation" and "concrete" types of pattern show in the gross no significant differences, and we have accordingly combined these two groups in the averages. The "interference" group in general brings about a marked delay,

and in several cases *O* reported that a figure was impossible. The table shows the reaction-times (in seconds) of all *O*'s for every stimulus, and the meaningful nature of the figures observed.

<i>Co</i>			<i>Su</i>			<i>Z</i>		
(1)	Cornucopiae		(1)	Hoop		(1)	Square	
	Cross in perspective		(2)	Square			Earth on axis	
	Hourglass			Cross			M	
	Square		(3)	Plus sign			Hoop	
(2)	Diamond			Z		(2)	Z	
	X			N			X	
(3)	H			V			N	
	M			X		(3)	Hor. parallels	
	Z		(4)	Vert. parallels			Vert. parallels	
	Square with one			Hor. parallels			Rt. angled tri-	
	diagonal			Oval			angle	
				Hexagon			Tilted division	
				Tilted division			sign	
				sign			Tilted T	

<i>H</i>			<i>Zi</i>		
(1)	Square		(1)	Diamond	
	Cross			Wheel	
	Black rectangle in perspective			End of pointed crystal	
(2)	N			Cross	
	Z			Circle	
	O			N	
	Diamond with horizontal bisec-		(2)	Oval	
	section			Z	
(3)	2 V's			Diamond with horizontal bi-	
	2 pairs of short parallels con-			section	
	verging left		(3)	Dotted V	
				Plus sign inside tilted square	
				Division sign	
			(4)	2 pairs of short parallels con-	
				verging left	

	Co	Su	H	Co	Su	H
1. Cepheus	15.2	24.	6.4	Curved globe	2 Δ 's, apices together	Crescent
2. Light bulb	9.4	14.4	5.	Tiny Christmas tree with lights	Oval on Δ base	Hanging chandelier
3. Triangle (In)	17.	27.2	33.8	Tent	Double V	Kite
4. Orion	14.2	27.	6.2	Dog sitting on hind leg	Light globe on base	? with legs as in funny papers
5. Bell	15.	12.6	3.8	Δ with cross line at top	Cross with support behind	Tent or pagoda
6. Square (In H)	22.4	18.2	9.4	Pyramid with apex toward me	Pyramid	Cylinder in perspective
7. Pleiades	11.8	21.8	4.8	Diminutive tennis racket	A sort of dipper	Dipper
8. Fork	7.2	2.8	1.8	Shovel	Banjo	Broom

9. Square (Out V)	18.2	33.4	12.2	An open fan	FAIL (Tri- angle) ²⁸	Balloon
10. Cassiopeia	4.8	11.	2.8	Butterfly	Tipped W	W
11. Coat of arms	9.	16.6	33.2	Small fruit tree	Leather bag	Fish bowl
12. Triangle (Out)	90.	16.	14.4	FAIL (geom. figure) ²⁸	Drawing in- strument	Coal scuttle
13. Little dipper	12.2	10.6	5.4	A flower	Dipper for pail	Kite
14. Pennant	43.2	7.6	7.2	A flag or pen- nant	Flag on pole	Lever & ful- crum
15. Square (Out H)	59.4	65.	7.6	Profile of face	FAIL (Tri- angle) ²⁸	Inverted chandelier
16. Sickie (Const.)	46.8	50.4	24.8	Question mark	Standard with hook light bulb	Hay hook
17. Hand mirror	16.	17.4	2.4	Ring with link	Circle with handle	Head calipers
18. Square (In V)	32.6	14.6	17.6	Pyramid with top toward me	Square with dented top	Hollow cup or can
Average Constell. Con- crete	17.06	18.01	8.65			
Average Inter- ference	39.93	29.06	15.83			

The *O*'s again reported the "form stage," during which the figure was indefinitely outlined and carried only a suggestive or tentative meaning. By eye-movement about its outline, or by fixation, the figure either completed itself processwise and was accepted with a more concrete meaning, or failed to take on a greater definiteness and was rejected. All *O*'s were set for a fairly concrete figure-meaning, and declared that the object-meaning, which came subsequently, was a confirmation of the suggested or tentatively accepted form-meaning.

The reaction-times throw further light upon the influence of meaning in determining the perception of form. Meaning and process are correlated aspects of the perception, and until both are somehow realized the perception is inadequate. The rôle of meaning is also brought into marked relief by the work with constellation-figures. In presenting these figures as arrangements of white dots upon a deep black background, we offered admirable external conditions for the suggestion of stellar constellations. But not a single *O* observed such a figure, because no *O* was set for such a meaning. One *O* called the "Little Dipper" a dipper, but described it as an ordinary utensil for a water-pail.

CONCLUSIONS

The net outcome of our experimental work is that the perception of visual form presents a dual problem of psychology and of applied logic. Taking the perception psychologically, and attempting to describe the content-processes

²⁸The name here was suggested, but rejected because it did not include all of the dots.

into which it resolves, we have been able to bring to light a variety of attributive patterns which serve as sensory cues to meaning. Taking the same perception logically, we have found a number of form-meanings, definitely correlated with these sensory cues. We have thus shown how identical stimuli, approached in different sets or attitudes, may arouse the perception of different forms, correlated with differing sensory emphases; and we have shown how different stimuli may arouse the same perception of form correlated with sameness of sensory emphasis.

For our modes of procedure we claim two advantages. In the first place, the method which we have followed has proved unexpectedly fertile on the side of process, and the resulting descriptions are detailed; and in the second place our discrimination of meanings is itself a small contribution towards a classification of the sort outlined in Weld's recent study.²⁹

We conclude from our experiments that the *Gestaltqualität* is a particular meaning established, under a general or particular set, upon particular and definitely correlated sensory data. If this reading is correct, the need of a new ideational content or character of relation or production is done away with; perception appears as an equivocal term, but with the gross reason for its equivocalness fully exposed.

²⁹ Weld, H. P., "Meaning and Process as distinguished by the Reaction Method," in *Studies in Psychology* (Titchener Commemorative Volume), 1917, 181 ff.